LIQUID CRYSTAL DISPLAY ELEMENT INTEGRATED WITH A TOUCH SENSOR

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to a liquid crystal display element integrated with a touch sensor, more particularly to a liquid crystal display element integrated with a touch sensor using a resistive membrane method.

2. Prior Art

Heretofore, it has been necessary to add a touch sensor unit as an external component to a liquid crystal display element when a touch panel function is given to the liquid crystal display element using, for example, a resistive membrane method.

FIG. **1** shows a liquid crystal display apparatus **1** having a conventional touch sensor function. That is, an upper electrode **8** is formed on a film **7** and a lower electrode **10** is formed on a glass substrate **6**. By laminating the film **7** and the glass substrate **6** via a spacer, a touch sensor unit **3** of the resistive membrane method is formed. There is a space **9** between the upper electrode **8** and the lower electrode **10**. Then, this touch sensor unit **3** is attached externally to a liquid crystal display element **2** composed of a back light **4** and a TFT array cell **5**.

However, as described above, attaching a touch sensor unit externally means adding the touch sensor unit as an extra component to the foregoing liquid crystal display element. This has resulted in thickening and weighting of the whole of the element. Additionally, this has resulted in creating an optically undesirable condition owing to degradation of performance such as transmissivity. For this reason, it has been difficult for an electronic apparatus required to be compact and light weight such as a note book type personal computer to be equipped with a touch sensor unit. Moreover, since a touch sensor unit of this kind is fabricated in a different process from that for a liquid crystal element, its cost has also increased.

To solve this problem, as shown in FIG. **2**, substituting a film **11** for the glass substrate **6** composing the touch sensor unit **3** has been investigated. This has improved the problem of thickness and weight to some extent, but it is unsatisfactory. Moreover, using a film has caused increase of cost conversely because of complexity of a fabricating process of a conductive thin film, as compared with a fabricating process of a glass substrate. And lack of strength and optical non-uniformity of a film has made it impossible to fabricate a touch sensor unit exhibiting full reliability and optical characteristics.

It is an object of the present invention to provide a compact and light weight liquid crystal display element incorporating a touch sensor unit. It is another object of the present invention to provide a liquid crystal display element incorporating a touch sensor unit exhibiting excellent position detectability by a touch operation.

SUMMARY OF THE INVENTION

A liquid crystal display element integrated with a touch sensor of the present invention comprises a first substrate, a second substrate opposing the first substrate, a liquid crystal layer interposed between the first substrate and the second substrate, a display electrode and a touch electrode disposed on the surface adjacent to the liquid crystal layer of at least either the first substrate or the second substrate. And a liquid crystal display element integrated with a touch sensor of the present invention has a pillar-shaped spacer, and has a convex-shaped part on which the touch electrode is provided.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

FIG. **1** is a cross-sectional view showing a liquid crystal display element having a touch sensor function of the prior art.

FIG. **2** is a cross-sectional view showing a liquid crystal display element having a touch sensor function of the prior art.

FIG. **3** is a cross-sectional view partially showing an example of a liquid crystal display element integrated with a touch sensor of the present invention.

FIG. **4** is a cross-sectional view showing an example of a liquid crystal display element integrated with a touch sensor of the present invention.

FIG. **5** is a plan view showing an example of a liquid crystal display element integrated with a touch sensor of the present invention.

FIG. **6** is a plan view showing an example of a liquid crystal display element integrated with a touch sensor of the present invention.

FIG. **7** is a plan view showing an example of a liquid crystal display element integrated with a touch sensor of the present invention.

FIG. **8** is a cross-sectional view partially showing an example of a liquid crystal display element integrated with a touch sensor of the present invention.

FIG. **9** is a cross-sectional view partially showing an example of a liquid crystal display element integrated with a touch sensor of the present invention.

FIG. **10** is a view illustrating position detection method of the present invention.

FIG. **11** is a perspective view schematically showing an example of a liquid crystal display element integrated with a touch sensor of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

FIG. **3** is a cross-sectional view showing an example of a liquid crystal display element integrated with a touch sensor of the present invention. A first display electrode **15** and a first touch electrode **16** are provided on a first substrate **14**, and a second display electrode **18** and a second touch **19** electrode are provide on a second substrate **17**. A liquid crystal layer **20** is interposed between the first substrate **14** and the second substrate **17**. The present invention can be applied to a liquid crystal display apparatus of both a reflective type and a transparent type.

FIG. **4** is a cross-sectional view showing another example of a liquid crystal display element integrated with a touch sensor of the present invention. The first display electrode **15** is formed on the first substrate **14**. In FIG. **4**, the first display electrode **15** is indicated as a pixel electrode. A color filter layer **21** and a black matrix layer **22** are provided on the second substrate **17**, and the second display electrode **25** is formed thereon.

In FIG. **4**, the second display electrode **25** is indicated as a common electrode.